2008

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University of Wollongong
Economics Working Paper Series 2008

http://www.uow.edu.au/commerce/econ/wpapers.html

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WP 08-14
November 2008

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This paper examines technical and pure technical efficiencies of ten major financial institutions in Botswana for each year during the period 2001-2006 using data envelopment analysis. In order to obtain more robust and reliable results, the sensitivity of our efficiency indices were put into test by choosing three alternative approaches in specifying the mix of inputs and outputs. The empirical results indicate that: (a) no matter which approach and year are taken into consideration, Baroda and FNB (which are both foreign banks) and BSB (which is a publicly owned institution) are consistently among the most efficient institutions and BDC, ABC and NDB are the least efficient ones; (b) the most efficient banks are either small or large institutions in terms of their asset sizes; (c) due to the small sample size, the evidence of a relationship between the age of institutions and their technical efficiencies remains inconclusive. One can conclude that financial institutions can further enhance efficiency by adopting self-service technologies such as telephone and internet banking which can substantially reduce their service delivery costs.

Keywords: Botswana, Technical efficiency, Data envelopment analysis, financial institutions.
JEL codes: C14; C61; G21; G2

I. INTRODUCTION

The review of the literature indicates that most studies examining the empirical efficiency analysis of financial institutions focus mainly on developed economies. However, this issue is also of paramount importance for developing economies which recently initiated various economic reforms with the aim of improving efficiencies of financial institutions. This paper specifically examines the relative efficiency of financial institutions in Botswana through time and using various input-output classification criteria.

One of the most important objectives of deregulation and financial liberalisation in Botswana, like any other countries, has been to improve efficiency among its financial institutions which play a pivotal role in allocation of scarce financial resources. This study can shed further light as to how successful these policies have been in terms of boosting efficiency of financial institutions during the period 2001-2006. Previous studies conducted for other countries have produced mixed results regarding the effects of deregulation and efficiency. See, for example, Bhattacharya *et al.* (1997); Leightner and Lovell (1998); Hao *et al.* (2001); Yildirim (2002); Isik and Hassan (2003); and Ataullah and Le (2006). These mixed results are consistent with a thorough review of previous studies on this same issue by Berger and Humphrey (1997), arguing that deregulation might not always improve efficiency and productivity. However, an important aim of most reforms in the financial institutions (including those for Botswana) is to enhance the level of competition amongst firms and to exert more pressure in utilising their resources more effectively. For example, Ataullah and Le (2006); Chen *et al.* (2005); and Canhoto and Dermine (2003) established a positive relationship between financial liberalisation and efficiency.

The financial system in Botswana has undergone legal, structural and institutional changes in recent years. Throughout the 1980s a series of financial reforms were introduced to boost the efficiency and productivity of financial institutions by enhancing the crucial role of market forces (Bank of Botswana (BoB) Annual Report, 2006). New entrants to the system and new products such as Automatic Teller Machines (ATM), credit and debit card services were permitted as a result. However, there are only a limited number of efficiency analyses in the context of Botswana's financial institutions. According to Favero and Papi (1995) efficiency analysis is also referred to as a strategic tool which can play a crucial role in tackling increasing competitive pressures and structural changes within financial institutions.

Most of the limited previous studies for developing countries focused mainly on the efficiency differentials among institutions with different ownership status and asset sizes. This can be due to the fact that their institutions were still at their infancy and/or their financial markets were usually characterised by high state ownership and rapid entry by foreign banks. The policy issues in these studies addressed the questions such as the privatisation of state-owned institutions, elimination of restrictions for domestic and foreign institutions entry and operational issues, and the existence of scale economies associated with mergers and acquisitions. For the review of some of these studies see, for example, Sathye (2003); Ataullah and Lee (2006) and Paxton (2007).

Regarding the effect of ownership status on institution's performance, previous studies reported totally different results between developed and developing economies. Domestic institutions in developed countries generally performed more efficiently than their foreign-owned counterparts. For example, Chang *et al*. (1998) conducted a comparative analysis of the productive efficiency of foreign-owned and the U.S-owned multinational commercial banks operating during the period 1984-1989. Chang *et al*. (1998) used a multi-product translog stochastic cost frontier model to estimate the cost inefficiency scores, while ordinary least squares and Tobit regressions were utilized to identify key factors associated with the resulting inefficiency indices. Their results indicated that foreign-owned multinational banks operating in the U.S were significantly less efficient than their U.S owned counterparts. They also found that large multinational banks holding fewer foreign assets were more efficient.

Previously, Hasan and Hunter (1996) obtained the same results and Peek *et al.* (1999) viewed that the inefficiency of foreign banks that enter the U.S market through acquisition could be contributed to the low performance of target banks compared to other domestic banks. On the other hand, Sathye (2003); Shanmugan and Das (2004), among others, found that foreign banks in developing economies were more efficient than domestic banks as they bring the state of the art technology and human capital into domestic banks. Similar to other developing economies, foreign institutions in Botswana are expected to be more efficient than public ones because most of them are multinational and as previously mentioned they are well established in terms of the optimal use of technology and human capital.

Based on the previous studies the firm size does matter when it comes to efficiency analysis and thus both models with variable returns to scale and constant returns to scale should be taken into consideration (McAllister and McManus, 1993; Wheelock and Wilson, 1999; Katib and Mathews, 2000). For example, Katib and Mathews (2000) applied Data Envelopment Analysis (DEA) in their study of the Malaysian banks from 1989 to 1995. Their results showed that average technical efficiency ranged from 68 percent to 80 percent and that most commercial banks did not operate at constant returns to scale. They also concluded that technical inefficiency was largely attributed to scale inefficiency. Hence it can be argued that analysts in their empirical investigations of the efficiency of financial institutions should allow, at least in principle, for the existence of variable returns to scale (VRS).

In this paper we adopt a non-parametric DEA model and assume the VRS in order to analyse the relationship between asset size and returns to scale. Even though DEA assumes no random error, its advantages in the context of this study outweigh its disadvantages. One of these advantages, which is more relevant to this study, is that DEA works well with small sample sizes. Unlike countries such as the United States where there are very large number of institutions, there are only relatively few financial institutions in Botswana and thus the industry is less suited to analysis using parametric techniques such as the use of stochastic production function. Of particular interest to this study is a paper by Drake (2001) who used a sample size of nine banks to study technical and scale efficiencies and productivity gains in the UK banking sector and his models successfully distinguished varying efficiencies among different banks.

The rest of this paper is structured as follows: Section II briefly discusses the way in which efficiency scores are measured by using DEA and by adopting both CRS and VRS assumptions. Section III deals with the sensitive issue of the specification of inputs and outputs employed in the evaluation of technical efficiency. The penultimate section presents the resultant efficiency scores for Botswana’s ten financial institutions and also assesses the main determinants of efficiency based on previous similar studies for developed and developing countries. The paper ends with some brief concluding remarks in Section V.

II. EFFICIENCY MEASUREMENT USING DEA

The DEA approach is based on a mathematical model developed by Charnes *et al.* (1978). However, according to Barr *et al*. (1999), since then several different mathematical programming DEA models have been proposed in the literature. Each of these models seeks to establish how the *n* DMUs determine the envelopment surface (the best practice efficiency frontier). The geometry of this envelopment surface depends on the specific DEA model adopted. In order to make detailed analysis of inefficient units and take corrective actions to improve their performance, this paper allows for both the constant returns to scale (CRS) assumption and the variable returns to scale (VRS) assumptions below.

Let us first assume that there are constant returns to scale, we can then formulate the following model:

Min $\quad l_0 - \varepsilon\left[\sum_{i=1}^{m} S_i^- + \sum_{r=1}^{s} S_r^+\right]$ (1)

Subject to: $\quad \sum_{f=1}^{N} \lambda_f x_{if} = l_o x_{if_o} - S_i^-$ where $i = 1...m$

$$\sum_{f=1}^{N} \lambda_f y_{rf} = S_r^+ + y_{rf_o} \quad \text{where } r = 1...s$$

$$\lambda_f \geq 0,\ f = 1...N,\quad S_i^-,\ S_r^+ \geq 0 \quad \forall\ i \text{ and } r$$

Where x_{if} and y_{rf} are levels of the i^{th} input and r^{th} output, respectively for DMU f. N is the number of DMUs. ε is a very small positive number (non-Archimedean) used as a lower bound to inputs and outputs. λ_f denotes the contribution of DMU f in deriving the efficiency of the rated DMU f_o (a point at the envelopment surface). S_i^- and S_r^+ are slack variables proxying extra savings in input i and extra gains in output r. l_o is the radial efficiency factor that shows the possible reduction of inputs for DMU f_o. If l_o^* (optimal solution) is equal to one and the slack values are both equal to zero, then DMU f_o is said to be efficient. When S_i^- or S_r^+ take positive values at the optimal solution, one can conclude that the corresponding input or output of DMU f_o can improve further once input levels have been contracted to the proportion l_o^*.

If a convexity constraint is incorporated in model (1), the following VRS version of the DEA model can be written as follows:

Min $\quad l_o - \varepsilon\left[\sum_{i=1}^{m} S_i^- + \sum_{r=1}^{s} S_r^+\right]$ (2)

Subject to: $\quad \sum_{f=1}^{N} \lambda_f x_{if} = l_o x_{if_o} - S_i^-$ where $i = 1...m$

$$\sum_{f=1}^{N} \lambda_f y_{rf} = S_r^+ + y_{rf_o} \quad \text{where } r = 1...s$$

$$\sum_{f=1}^{N} \lambda_f = 1$$

$$\lambda_f \geq 0,\ f = 1...N, S_i^-, S_r^+ \geq 0 \quad \forall\ i \text{ and } r$$

This model differs from model (1) in that it includes the so-called convexity constraint, $\sum_{f=1}^{N} \lambda_f = 1$ which prevents any interpolation point constructed from the observed DMUs from being scaled up or down to form a referent point which is not permissible under the VRS. In this model, the set of λ values minimise l_o to l_o^* and identify a point within the VRS model whose input levels reflect the lowest proportion of l_o^*. At l_o^*, the input levels of DMU f_o can be uniformly contracted without detriment to its output levels. Therefore, DMU f_o has efficiency equal to l_o^*.

The solution to model (2) is summarized in the following fashion: DMU f_o is pareto-efficient if $l_o^* = 1$ and $S_r^{+*} = 0,\ r = 1...s,\ \ S_i^{-*} = 0,\ \ i = 1...m$. Technical efficiencies assessed under VRS are referred to as pure technical input efficiency as they are net of any scale effects.

If the convexity constraint in model (2) is dropped, one obtains model (1), which can generate technical input efficiency under CRS. This implies that pure technical input efficiency of a DMU is always greater or equal to its technical input efficiency. Under both CRS and VRS assumptions, the resulting scale efficiency can be measured since in most cases, the scale of operation of the firm may not be optimal. The firm involved may be too small in its scale of operation, which might fall within the increasing returns to scale part of the production function. Similarly, a firm may be too large and operate within the decreasing returns to scale part of the production function. In both cases, efficiency of the firms may be improved by changing their scale of operation. If the underlying production technology follows constant returns to scale technology, then the firm is automatically scale efficient. Under CRS and VRS assumptions, technical efficiency scores for each method can be compared. The resulting ratio illustrates scale efficiency which is the impact of scale size on the productivity of a DMU. Formally, the scale input efficiency of DMU f_o is given as $\left(TIE / PTIE\right)$. Where, TIE and $PTIE$ are technical input efficiency and pure technical input efficiency of DMU f_o, respectively.

Since pure technical efficiency is always greater or equal to technical efficiency, it means that scale efficiency $\left(TIE / PTIE\right)$ is less or equal to unity. If technical efficiency and pure technical efficiency of a DMU are equal, then scale efficiency is equal to one. This means that irrespective of scale, size has no impact on efficiency. If CRS is less that VRS then scale efficiency will be below unity meaning that the scale of operation does impact on the productivity of the DMU.

III. SPECIFICATION OF INPUTS AND OUTPUTS

There is no consensus in the literature regarding the specification of outputs and inputs in the frontier modelling. However, it is commonly acknowledged that the choice of variables in efficiency studies significantly affects the results. The problem is compounded by the fact that the choice of variables (both inputs and outputs) is often constrained by the availability of data on relevant variables. The input and output measurements are especially difficult because most financial services/products are jointly produced and prices are typically assigned to a bundle of financial services. However, there are several different approaches in the literature regarding the specification of input-output mix. *Inter alia*, these include the production approach, the intermediation approach and more recently, the modern approach, the operating approach, the asset approach and the user cost approach. For a detailed account of these approaches see Das and Ghosh (2006) and Favero and Papi (1995).

One can argue that each method has its own merit and can be considered appropriate if their underlying assumptions hold. It is apparent that financial institutions undertake diverse functions simultaneously. However, given data constraints, we examine the robustness and sensitivity of our estimated efficiency scores by using value-added, intermediation and operating approaches.

According to the intermediation approach, financial institutions are regarded as intermediators that transform and transfer financial assets from savers to borrowers. Financial institutions produce intermediation services through the collection of deposits and other liabilities and then utilise them in interest-earning assets, such as loans, securities and other types of investments. This approach includes both operating and interest expenses as inputs, whereas loans and other major assets count as outputs. This approach has been applied in developing countries *inter alia* by Sathye (2003), Paxton (2006) and Das and Ghosh (2006).

The value-added approach on the other hand identifies assets or liabilities in balance-sheet as outputs because they lead to the generation of more value added. In general, under this approach, the major categories of deposits and loans are viewed as outputs because they constitute a significant proportion of value added component.

Finally, the operating approach (or income-based approach) views financial institutions as business units with the final objective of generating more revenues given total costs incurred for running a business (Leightner and Lovell, 1998). This approach defines institutions' output as total revenues (interest and non-interest) and their inputs as total expenses (paid interest and operating expenses). Selected inputs and outputs under various alternative approaches employed in the study are summarized in Table 1.

Table 1: Choice of input/output variables under the three approaches [a]

Approach	Inputs	Outputs
	Deposits	Loans
Intermediation approach	Labour (salaries)[1]	
	Capital related operating expenses	Investment
Value-added approach	Labour (salaries)	Loans
	Capital related operating expenses	Investment
		Deposits
	Interest expenses	
	Interest expenses	Interest income
Operating approach	Labour(salaries/employee expenses)	
	Capital related operating expenses	Non-interest income

[a] All inputs/outputs variables are measured in thousands of Pula.

Since DEA is appropriate for the efficiency analysis even if the sample size is small, we utilise this technique to examine only those financial institutions for which the required data for the three approaches were available during 2001-2006. The sample therefore includes ten financial institutions comprising both banking and non-banking institutions. Distinguishing Botswana's banking institutions from its non-bank institutions leads to the loss of data and therefore the number of inputs and outputs will not be commensurate with respect to the sample size. The data are

[1] The implication that labour salaries are a good proxy for labour's input to actual output is not necessarily established beyond doubt.

obtained from annual financial statements available in the institutions' annual reports for the years 2001-2006.

IV. EMPIRICAL RESULTS

Equations 1 and 2 have been used to conduct an efficiency analysis of Botswana's ten formal financial institutions and the results are classified into two main groups. The estimates of overall efficiency during the sample period (2001-2006), under the three alternative approaches are first described. Second, univariate cross-tabulation approach is employed to trace any discernable relationship of efficiency with age, ownership structure and other aspects of financial institutions. The univariate approach has been widely employed in empirical studies on financial institutions' efficiency by, for example, Wheelock and Wilson, (1999); Das and Ghosh, (2006).

The results of technical efficiency estimates under each of the three approaches (namely value-added, intermediate and operating) have been presented in Table 2. It should be noted that all columns of Table 2 have been sorted in descending order according to the magnitude of the average efficiency index (2001-2006) reported in the last column so that the most efficient institutions can appear at the top under each of the three approaches. The technical efficiency estimates reported in this table represents all optimal values based on the assumption of the constant returns to scale model (equation 1) for each of the ten financial institutions.

Table 2: Average Technical Efficiency of Financial Institutions, 2001-2006

Approach/Year	2001	2002	2003	2004	2005	2006	Average efficiency (*E*)
			Value-added				
Bank of Baroda	1	1	1	1	1	1	1
Botswana Savings Bank	1	1	1	1	1	1	1
First National Bank	0.775	0.715	0.798	1	1	0.936	0.871
Botswana Building Society	0.782	0.665	0.678	0.812	0.645	0.588	0.695
Standard Chartered Bank	0.856	0.873	0.689	0.522	0.495	0.630	0.678
Stanbic Bank	0.697	0.528	0.52	0.866	0.839	0.555	0.668
Barclays Bank	0.786	0.715	0.689	0.648	0.570	0.566	0.662
Botswana Development Corporation	0.654	0.588	0.712	0.645	0.558	0.662	0.634
African Bank Corporation	0.287	0.266	0.291	0.850	0.133	0.105	0.322
National Development Bank	0.221	0.233	0.248	0.200	0.133	0.104	0.190
Average	0.706	0.658	0.663	0.754	0.637	0.615	0.672

Table 2 Continued

Approach/Year	2001	2002	2003	2004	2005	2006	Average efficiency (E)
			Intermediation				
Bank of Baroda	1	1	1	1	1	1	1
Botswana Savings Bank	1	1	1	1	1	1	1
First National Bank	0.712	0.782	0.736	1	1	1	0.872
Barclays Bank	0.639	0.629	0.654	0.718	0.741	0.723	0.684
Standard Chartered Bank	0.627	0.632	0.616	0.654	0.630	0.632	0.632
Botswana Building Society	0.446	0.459	0.425	0.672	0.716	0.778	0.583
Botswana Development Corporation	0.313	0.330	0.326	0.342	0.554	0.922	0.465
Stanbic Bank	0.650	0.610	0.332	0.318	0.303	0.439	0.442
African Bank Corporation	0.345	0.343	0.308	0.432	0.402	0.399	0.372
National Development Bank	0.256	0.231	0.251	0.305	0.340	0.338	0.287
Average	0.600	0.602	0.565	0.644	0.669	0.723	0.634
			Operating				
Bank of Baroda	1	1	1	1	1	1	1
Botswana Savings Bank	1	1	1	1	1	1	1
First National Bank	0.702	0.678	0.862	0.941	0.976	0.977	0.856
Stanbic Bank	0.917	0.882	0.507	0.477	0.504	0.465	0.625
Standard Chartered Bank	0.516	0.588	0.634	0.344	0.343	0.502	0.488
Botswana Building Society	0.482	0.493	0.429	0.411	0.485	0.574	0.479
Barclays Bank	0.538	0.597	0.416	0.397	0.369	0.454	0.462
National Development Bank	0.401	0.367	0.332	0.309	0.303	0.434	0.358
African Bank Corporation	0.203	0.202	0.204	0.208	0.123	0.187	0.188
Botswana Development Corporation	0.104	0.098	0.099	0.102	0.113	0.174	0.115
Average	0.586	0.591	0.548	0.519	0.522	0.577	0.557

Source: Authors' calculations.

The empirical results suggest that there exists a degree of asymmetry between institutions regarding their technical efficiency. As expected, the different approaches based on the different specification of input/output mix of institutions produced different efficiency estimates.

However, it is interesting to note that based on Table 2 the estimates of technical efficiency are overall higher under value-added approach (67 percent) than those of the intermediate approach (63 percent) and the operating approach (56 percent). This is not counter-intuitive as in general, the use of more number of inputs/outputs leads to higher efficiency score. According to Das and Ghosh (2006), this issue is known in the literature as the 'curse of dimensionality' when there are a few firms in the sample and many inputs/outputs. This is particularly the case in the context of the present study under the value-added approach. As a result, DEA scores under the value-added approach are higher than those of the other two approaches for all years 2001-2006. At best the mean value of *E* under the value-added approach is 67 percent, implying that there is a considerable scope for financial institutions in Botswana to reduce the use of their inputs by at least 33 percent without having to reduce their outputs over the period under investigation.

Based on our bank-specific results in Table 2, Bank of Baroda (BRB) and Botswana Savings Bank (BSB) are technically more efficient on the basis of all of the three approaches. It should be noted that BRB is a foreign bank and according to Sathye (2003), it also performs efficiently in its head office in India. On the other hand, BSB is the only public deposit-taking bank in Botswana and as such this bank is regarded as the largest provider of banking services to rural areas through its collaboration with the Botswana Postal Services. Siphambe *et al.* (2005) argue that the extension of the service delivery and success of BSB is largely attributable to the government monitoring and controls.

The results in Table 2 also indicate that First National Bank (FNB) improved its status after 2003 from a low efficiency level to high efficiency levels. It is interesting to note that 2003 coincides with the introduction of self-service technologies (SSTs) such as the internet and telephone banking which are highly likely to have contributed to the increased efficiency of FNB. We found that National Development Bank (NDB) possessed the lowest efficiency scores under the first two approaches. This is a public development bank with the purpose of investing in agricultural activities, which are inherently unpredictable because of climatic changes and, hence the sector is associated with increasing default risks. Das and Ghosh, (2006) argue that default risks are one of the contributing factors to inefficiencies within the banking industry.

Overall, the findings presented in Table 2 clearly show a high degree of inefficiency within the financial sector of Botswana during the sample period. While most of these inefficiencies stem from non-optimal use of inputs, they could also be attributed to adverse macroeconomic conditions and financial instability particularly following the introduction of the value-added tax (VAT) in 2002 and the devaluation of the Pula (Botswana's currency) in 2005. The devaluation of the Pula and the introduction of VAT followed by a bout of inflationary pressures which resulted in further exchange rate depreciation, high taxes and eventually poor loans portfolios and a non-competitive financial system (Siphambe *et al.* 2005). The period 2001-2006 can also be characterised by a number of conflicting policy signals conducted by Botswana's monetary and fiscal authorities that caused their credibility to dwindle away.

Based on all approaches, the overall efficiency score of 0.62 lies within an acceptable range reported in other studies but this figure is clearly lower than the world mean efficiency score of 0.86 found by Berger and Humphrey (1997). One then can conclude that financial institutions in Botswana should utilise their resources more efficiently to further improve their efficiency so that they can catch up with the rest of the world. The government also needs to support these institutions, especially those owned by the public sector such as NDB, by creating an environment which is conducive to effective use of scarce resources. For instance, further monitoring projects can reduce default risk and hence improve efficiencies of the institutions concerned.

Determinants of efficiency: Univariate approach

In this section, a univariate approach is employed to investigate the determinants of technical efficiency by cross-tabulating it to factors such as size, ownership status, age and non-performing loans. In the literature, there are a number of other factors that have been considered in terms of their impacts on the efficiency of financial services. For example, Rangan *et al.* (1988) included an index of product diversity in their DEA study of the U.S commercial banks, and Ferrier and Lovell (1990) incorporated the average size of loans and deposits accounts across a range of the U.S deposit-taking institutions. Worthington (2000) highlights the fact that there may be a degree of conflict between strictly-efficient performance and compliance with capital adequacy requirements and other regulations. Unfortunately, in the context of Botswana there is no such data available at the present time.

Technical efficiency and institution size

The size of an institution in this paper is determined by the amount of its assets. In Table 3 we have classified all the ten banks into three categories: category I representing small banks with assets less than 1 million Pula, category II including medium-sized institutions with assets between 1-2 million Pula and category III consisting of large banks with assets greater than 2 million Pula.

Table 3: Technical Efficiency and Institution Size, 2001-2006

Year	Asset size categories		
	I	II	III
Value-added approach			
2001	0.751	0.546	0.806
2002	0.725	0.461	0.768
2003	0.732	0.508	0.725
2004	0.753	0.787	0.723
2005	0.695	0.510	0.688
2006	0.673	0.441	0.711
Intermediate approach			
2001	0.751	0.436	0.659
2002	0.725	0.428	0.681
2003	0.732	0.322	0.669
2004	0.753	0.364	0.791
2005	0.695	0.420	0.790
2006	0.673	0.587	0.785
Operation approach			
2001	0.721	0.408	0.585
2002	0.715	0.394	0.621
2003	0.690	0.270	0.637
2004	0.680	0.262	0.560
2005	0.697	0.247	0.562
2006	0.752	0.275	0.644

Source: Authors' calculations.
Note: I = Assets less than 1 million Pula.
II = Assets exceeding 1 million Pula up to 2 million Pula.
III = Assets greater than 2 million Pula.

According to the results presented in Table 3, under all of the three approaches, small institutions in category I and large institutions in category III exhibit much higher efficiency levels than that of the medium-sized banks. Thus the size of a financial institution does matter when it comes to its efficiency. As an important finding of this paper, it appears that the efficient ones are either "small" or "large".

Table 4: Average Technical Efficiencies, 2001-2006

Institution	Technical Efficiency	Assets (Pula)	Asset size category	Nature of Returns
Barclays	0.603	5686125	III	DRS
Standard	0.599	4202741	III	DRS
FNB	0.866	3724488	III	DRS
Baroda	1.000	270920	I	CRS
Stanbic	0.578	1216603	II	DRS
NDB	0.278	513153	I	IRS
BDC	0.405	1327012	II	IRS
BBS	0.586	673295	I	IRS
BSB	1.000	541628	I	CRS
ABC	0.293	1895775	II	DRS

Source: Authors' calculations and BoB financial reports (various years).
Note: DRS = Decreasing Returns to Scale, CRS = Constant Returns to Scale, IRS = Increasing Returns to Scale.

Table 4 indicates that among the large institutions, FNB has a higher efficiency score of 87 percent and this could be partly explained by the fact that FNB is the only financial institution in Botswana that has ventured into the use of modern technology such as the internet and telephone banking. As a group, the large institutions benefited from their international orientation and goodwill due to the fact that they are believed to be more stable. The relatively higher efficiency of large institutions could also be attributed to their ability to secure benefits resulting from economies of scale.

On the other hand, both Tables 3 and 4 reveal that small institutions are more efficient than medium-sized institutions. The most efficient small institutions are Bank of Baroda and Botswana Savings Bank (BSB) in category I. One may argue that due to their small scale of operation within a well-targeted market segment, they can be managed more effectively. These results therefore, suggest the possibility of a U-shaped relationship between the size and efficiency of the institutions in Botswana. However, based on the second and last columns of Table 4, one may conclude that those small institutions experiencing an increasing return to scale phenomenon such as BBS and NDB can further improve their efficiency by perhaps increasing their size. On the other hand, large institutions witnessing decreasing return to scale such as Stanbic, ABC, Barclays and Standard could boost their current levels of efficiency by trimming down their size. This provides some evidence supporting scale inefficiencies in the context of Botswana's financial institutions which is consistent with the findings of Drake (2001) in his similar study of the U.K banks. Drake (2001) and Chen *et al.* (2005) also found that smaller banks were subject to increasing returns to scale, whereas larger banks mainly exhibited decreasing returns to scale. However, according to Berger (1993) this is different from the U.S experience where the average cost curve has a flat U-shape indicating the efficiency of medium sized banks.

Technical efficiency and ownership

According to the results presented in Table 5, under all of the three approaches, foreign institutions exhibit much higher efficiency levels than those of public institutions. The high efficiency estimates for foreign institutions could be attributed to high management expertise and exposure to the world-wide competitive practices since most of the foreign institutions are multinationals. It is unlikely that public institutions by virtue of undertaking most of the government borrowing programs can generate sufficient fee-based income from their activities thus tend to be less efficient.

Table 5: Technical Efficiency and Ownership, 2001-2006

Year/Institution group	Public	Foreign
Value-added approach		
2001	0.664	0.734
2002	0.622	0.683
2003	0.660	0.665
2004	0.664	0.814
2005	0.584	0.672
2006	0.589	0.632
Intermediation approach		
2001	0.504	0.662
2002	0.505	0.666
2003	0.501	0.608
2004	0.580	0.687
2005	0.653	0.679
2006	0.760	0.699
Operating approach		
2001	0.496	0.646
2002	0.489	0.658
2003	0.465	0.604
2004	0.456	0.561
2005	0.475	0.553
2006	0.546	0.598

Source: Authors' calculations.
Note: Public institutions include BBS, BSB, BDC, NDB and foreign institutions are Baroda, Barclays, Standard, FNB, ABC, and Stanbic.

Sathye (2003) and Shanmugan and Das (2004) *inter alia* also found that foreign banks in developing economies were more efficient than domestic financial institutions as they bring state of the art technology and human capital into domestic institutions. On the contrary, domestic institutions in developed countries generally performed more efficient than their foreign-owned counterparts. For example, Chang *et al.* (1998) found that foreign-owned multinational banks operating in the U.S were significantly less efficient than their U.S-owned counterparts. Hassan and Hunter (1996) also found that domestically owned U.S banks were substantially more cost effective than Japanese banks operating in the U.S.

In this study, however, the government ownership is observed to be adversely associated with the efficiency of public financial institutions in Botswana. Several reasons can be provided in support of this finding. First, as Das and Ghosh (2006) stated, public institutions are often perceived as having multiple goals. The liberalisation process may have created an overt focus on profit maximisation and certain peripheral objectives such as encouraging employment of low skilled workers. Second, it also seems likely that in pursuance of government policy objectives, managers in these institutions might have followed a strategy of advancing greater quantum of loans by giving a particular sector high priority. Loans are then provided at below market rates and they could end up yielding a low return on advances, for example, NDB finances only agricultural projects which are unpredictable and subject to weather conditions and, hence highly prone to default risks.

Technical efficiency and age of the institution

The age of an institution in this paper is determined by the number of years an institution has been operating. In Table 6 all the ten institutions have been classified into new and old categories: the new category represents institutions that have been in operation for less than ten years and the old category consists of institutions that have been in the market for more than ten years.

Table 6: Technical Efficiency and Age, 2001-2006

Year/Age	New	Old
Value-added approach		
2001	0.644	0.721
2002	0.633	0.665
2003	0.646	0.667
2004	0.925	0.712
2005	0.567	0.655
2006	0.553	0.630
Intermediate approach		
2001	0.673	0.580
2002	0.672	0.584
2003	0.654	0.542
2004	0.716	0.626
2005	0.701	0.661
2006	0.700	0.729
Operating approach		
2001	0.602	0.583
2002	0.601	0.588
2003	0.602	0.535
2004	0.604	0.498
2005	0.561	0.512
2006	0.593	0.573

Source: Authors' calculations.
Note: New = Institutions in operation for less than 10 years.
Old = Institutions in operation for more than 10 years.

The results exhibit that only according to the value-added approach do old institutions demonstrate higher efficiencies than those of new ones. However, the intermediation and operating approaches generally find that new institutions are more efficient. Economically, new banks with their leaner and skilled workforce are better placed to implement sophisticated risk management techniques and operational innovations and are also well equipped to internalise the recent innovation in banking practices. This might be an important factor driving the result. Canhoto and Dermine (2003) also found evidence that new banks dominate the old ones in terms of efficiency in Portugal while Paxton (2007) found the opposite result for Mexico.

Technical efficiency and non-performing loans

Efficiency estimates under various non-performing loan (NPL) classifications are presented in Table 7 which are based on the ratio of NPL as a percentage of total loans. The results show that irrespective of the choice of inputs and outputs high levels of NPLs are associated with low efficiency estimates and vice versa. Berger and DeYoung (1997) assert that these kind of results are supportive of the 'bad management hypothesis'. That is to say, rising non-performing loans will usually exacerbate the inefficiencies of financial institutions due to the resulting increases in spending on monitoring, administering and selling off these loans. Based on these results it can be argued that one of the sources of inefficiencies could be attributed to the extent to which banks possess non-performing loans.

Table 7: Technical Efficiency and Non-Performing Loans, 2001-2006

Year/NPL (%)	Less than 10	10-20	More than 20
Value-added approach			
2001	0.852	0.574	0.221
2002	0.805	0.506	0.233
2003	0.783	0.560	0.248
2004	0.839	0.769	0.200
2005	0.817	0.445	0.133
2006	0.781	0.452	0.104
Intermediation approach			
2001	0.771	0.368	0.256
2002	0.776	0.377	0.231
2003	0.723	0.353	0.251
2004	0.782	0.482	0.305
2005	0.779	0.557	0.340
2006	0.799	0.700	0.338
Operating approach			
2001	0.779	0.401	0.263
2002	0.791	0.367	0.264
2003	0.737	0.332	0.244
2004	0.693	0.309	0.240
2005	0.699	0.303	0.240
2006	0.733	0.434	0.312

Source: Authors' calculations.
Note: NPLs are measured as percentage of total loans

V. SUMMARY AND CONCLUSIONS

This paper empirically analysed the technical efficiency of ten major financial institutions in Botswana using data envelopment analysis which is a non-parametric approach for each year during the period 2001-2006. In order to assess the robustness and sensitivity of our results, we have employed three different approaches to specify different combinations of inputs and outputs: value-added, intermediation and operating approaches. The four major findings of this paper are discussed briefly below.

First, it is found that the average yearly technical efficiency estimates under the value-added approach were mostly higher than the other two approaches. The overall average efficiency score under the three approaches during the sample period for all Botswana's financial institutions is 0.62 and this figure lies within an acceptable range reported for other developing countries. However, this level of efficiency is clearly lower than the world mean efficiency score of 0.86 found by Berger and Humphrey (1997). One can conclude that financial institutions in Botswana should utilise their resources more efficiently to further improve their efficiency so that they can catch up with the rest of the world. The government also needs to support these institutions, especially those owned by the public sector such as NDB, by creating an environment which is conducive to effective use of scarce resources. For instance, further monitoring of projects can reduce default risk and hence improve efficiencies of the institutions concerned.

Second, it appears that the high efficient institutions are either small or large in terms of the magnitude of their financial assets. These results therefore, suggest the possibility of a U-shaped relationship between efficiency and size of the financial institutions in Botswana. Third, financial institutions need to adopt self-service technologies such as telephone and internet banking in order to improve their efficiency levels through a substantial reduction in their service delivery costs. According to Avkiran (2000), the use of new information technology has been described as one of the cost effective ways for the delivery of financial services. For example it can be stated that FNB improved its efficiency level markedly as a result of establishing telephone and internet banking. Lastly, unlike Das and Ghosh (2006) who stated that opening more branches in rural areas can reduce the efficiency level of banks, this study provide evidence that this is not necessarily the case for Botswana. For example our results indicate that BSB with many branches in rural areas still enjoys a high level of efficiency. This is consistent by the findings of Favero and Papi (1995) in the context of India that location *per se* is not a major determinant of the efficiency of financial institutions.

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